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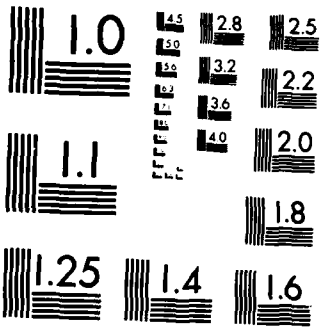

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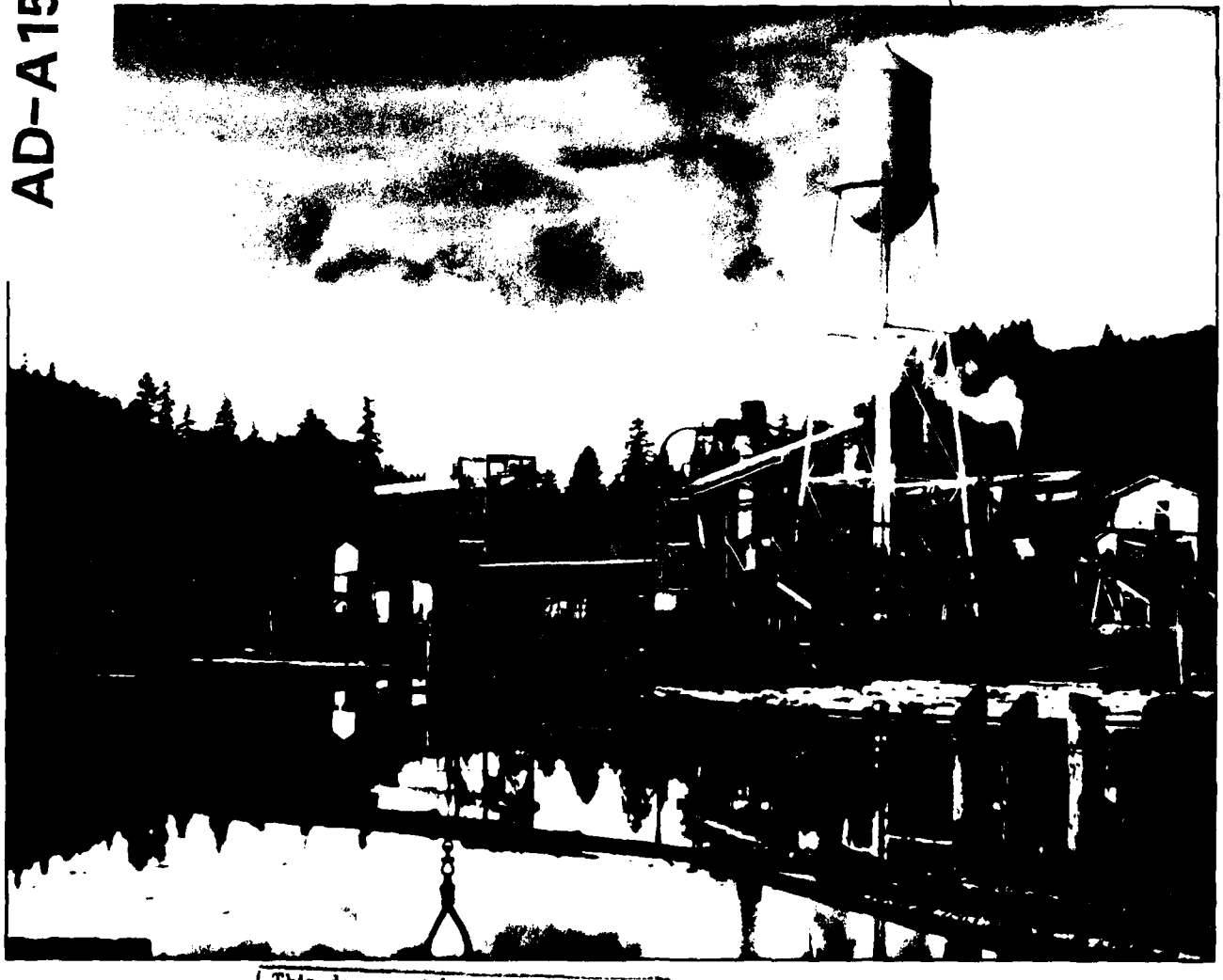
Investment Limits for Small-Scale SDR and EGAR Sawmills

George B. Harpole



Abstract

Market prices, roundwood costs, and other operating factors are used to formulate algorithms that may be used for estimating investment limits for small-scale SDR (Saw-Dry-Rip) and EGAR (Edge-Glue-and-Rip) sawmills. Algorithms are derived from results of discounted cash flow analyses approximating mills producing between 6 million and 12 million board feet per year (two-shift basis). The equations presented provide an approximating method which can be useful for assessing economic potentials for totally new mills, or modification of existing mills for production of SDR or EGAR lumber, and can be expected to be useful for structuring more detailed analyses for final assessments.

Keywords: SDR sawmills, EGAR sawmills, utilization economics, financial analysis.

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Investment Limits for Small-Scale SDR and EGAR Sawmills

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Introduction

A viable investment must produce an output that can be sold to generate enough revenue to cover operating costs, return capital investment, and produce sufficient profit to attract investment monies. Market prices, roundwood costs, and other operating costs essentially establish investment limits for new sawmills or converting old sawmills to new products. Using such operating factors, this paper provides equations for estimating maximum investments for building or converting a sawmill to use the SDR (Saw-Dry-Rip) and EGAR (Edge-Glue-and-Rip) processes to manufacture between 6 million and 12 million board feet (two-shift basis) of random length structural lumber per year from low- to medium-density hardwoods. This paper also includes examples for both new and converted mills, based on typical economic assumptions.

The equations are derived from discounted cash flow analyses and are linear, even though discounted cash flow analyses do not yield linear results when using different estimates for input. However, results are close enough to being linear to expect estimating errors to be approximately ±5 percent of discounted cash flow results when estimates of change are within ±30 percent of those used for deriving equations, as displayed in the appendix.

This procedure should only be used as a preliminary step to assess potential investment viability. All site-specific costs and related investment factors should be identified and used for more careful analysis to provide a basis for final assessment.

SDR and EGAR

The SDR process is innovative, enabling manufacture of quality structural lumber from low- to medium-density hardwoods by eliminating the traditional problem of warp. Logs are live sawn on the same plane into 7/4 (1-3/4-in.-thick) flitches (Boone and Maeglin 1980, Gerhards 1983, Maeglin 1978, Maeglin and Boone 1983). The flitches are rough edged to make compact kiln loads, dried to an average moisture content of ± 12 percent (dry basis), and then ripped to width and dressed for use.

EGAR mills are compatible with SDR mills and can utilize even small logs to produce lumber of any width from live-sawn flitches edge-glued together and ripped to the desired width (Bulgrin and others 1978, Kling 1979). SDR or EGAR are significant because they offer the opportunity to better utilize the 68 billion cubic feet of hardwoods now growing on U.S. commercial forest lands east of the Rocky Mountains (U.S. Department of Agriculture 1980).

Size Limits for SDR and EGAR Mills

Economic efficiency of lumber manufacture is largely associated with a balance of equipment, labor, and management that maximizes productivity with respect to the fixed costs of facilities and management. For sawmills, the most economical size seems to be between 45 million and 60 million board feet per year (Harpole 1983, Harpole and others 1981). Less economic, but more realistic, mill sizes for many circumstances in the hardwood regions, however, suggest smaller mills designed to produce between 6 million and 12 million board feet per year. Smaller concentrations of timber and geographic barriers often limit mill size.

Equations for New SDR and EGAR Mills

Investment limits for the SDR and EGAR mills were estimated using discounted cash flow techniques and previous economic evaluations of SDR and EGAR (Harpole 1983, Harpole and others 1981, Harpole and others 1979, Stumbo 1981).

The following equation may be used to estimate investment limits for SDR and EGAR sawmills and working capital requirements on the basis of other revenue, wood costs, and IRR assumptions.

$$SDR\$L = (2.08 - (IRR*0.054))*((Q((2.15*AR) - (4.729*WC))) - 1{,}027{,}749) \quad (1)$$

$$EGAR\$L = (2.075 - (IRR*0.043))*((Q((1.9003*AR) - (4.3476*WC))) - 1{,}018{,}700 \quad (2)$$

where

SDR$L = investment limit for cost of SDR facility in dollars
EGAR$L = investment limit for cost of EGAR facility in dollars
IRR = desired after-tax internal rate of return expressed as a percent
Q = output of lumber per year in thousands of board feet
AR = average realization for lumber in dollars per thousand board feet
WC = average cost for roundwood in dollars per cord (assumes 78 ft^3 of solid wood per cord).

Working capital requirements must be estimated and added to the investment limit for facilities to estimate total investment limit. Working capital requirements may be estimated using the following equation:

$$SWK = 35{,}838 + (14.29 * Q) \quad (3)$$

$$EWK = 41{,}675 + (14.87 * Q) \quad (4)$$

where

SWK = estimated working capital requirement for SDR mill in dollars
EWK = estimated working capital requirement for EGAR mill in dollars
Q = annual output of lumber in thousands of board feet.

For a new EGAR mill, the following equations can be used to calculate investment limits.

Once an investment limit has been calculated, an approximate budget for various cost components for facilities construction can be calculated on the basis of assignments to known construction costs and distributions of any balance on the basis of estimated costs.

Table 1 presents the author's best estimate of likely distributions of costs to various construction categories, allowing 10 percent of the total investment limit to cover some disparities. If a sawmill cannot be constructed within given investment limits, then there should be serious concern to whether the project can be made economically viable.

Table 1.—Estimates of investment limits for SDR and EGAR sawmills producing 12 million board feet of lumber per year (1984 basis)[1]

Item	SDR mill[2]		EGAR mill[3]	
	Dol (pct)			
Facilities investment limits				
Land and site preparation	$ 122,500	(4.90)	$ 122,500	(4.08)
Buildings	150,000	(6.00)	200,000	(6.67)
Processing equipment	1,427,500	(57.10)	1,777,500	(59.25)
Dry kilns	300,000	(12.00)	300,000	(10.00)
Mobile equipment[4]	250,000	(10.00)	300,000	(10.00)
Contingencies	250,000	(10.00)	300,000	(10.00)
Facilities total	$2,500,000	(100.00)	$3,000,000	(100.00)
Working capital[5]	207,344		220,115	
Investment limits, total	$2,707,344		$3,220,115	

[1]Components and relationship of costs largely derived from previous work by author (Harpole 1979 and 1983).

[2]Investment limits for SDR mill based on average realization of $237/1,000 fbm and operating costs and tax allowances from tables A-1 and A-2.

[3]Investment limits for EGAR mill based on average realization of $280/1,000 fbm and operating costs and tax allowances from tables A-3 and A-4.

[4]Assumes replacement of mobile equipment at end of fifth year of operating.

[5]Working capital for SDR mill = $35,838 + ($14.29*1,000 fbm output). Working capital for EGAR mill = $41,675 + ($14.87*1,000 fbm output).

Equations for Modifying Mills to Use SDR or EGAR

Because there are many situations where existing sawmills may be modified to allow production of SDR and EGAR lumber, estimating investment limits for such modifications can be useful. Equations (5) through (8) are based on the same assumptions and discounted cash flow analyses as equations (1) through (4) and may be used for estimating investment limits for mill modifications. The fundamental requirement for application of the following equations is that the candidate sawmill is similar to the described SDR or EGAR sawmill, except for facility components and their related operating costs that might be introduced to accomplish an SDR- or EGAR-operating standard. Estimated investment limits from equations (5) through (8) should be fairly accurate (± 5 pct) for mills already producing from 6 million to 12 million board feet of lumber per year on a two-shift basis. For modifying sawmills with intentions to expand operations to a second-shift for producing SDR lumber, conventional engineering economy methods should be used for evaluation because of the effects of full-second shift labor, power, maintenance and other operating costs. Justification for using the following procedures for estimating investment limits is where SDR or EGAR lumber production only replace existing production of other types of wood products.

Equation (5) may be used to estimate investment limits associated with an increase in average lumber realization and/or reduction in wood costs. (That is, if some portion of ongoing production time is given to production of SDR lumber under conditions where the difference between revenues from lumber and associated wood costs is increased, the increase in profit contribution can be expected to provide a basis for new investment):

$$\text{SDR \$L}/\Delta\text{AR \&/or}\Delta\text{WC} = \bar{Q}[\Delta\text{AR}(4.4720 - 0.1161 * \text{IRR}) - \Delta\text{WC}(9.8363 - 0.2554 * \text{IRR})] \quad (5)$$

$$\text{EGAR \$L}/\Delta\text{AR \&/or}\Delta\text{WC} = \bar{Q}[\Delta\text{AR}(3.9431 - 0.0814 * \text{IRR}) - \Delta\text{WC}(9.0213 - 0.1869 * \text{IRR})] \quad (6)$$

where

- SDR $L = change for SDR investment limit in dollars
- EGAR $L = change for EGAR investment limit in dollars
- ΔAR = expected change in average realization expressed in dollars
- ΔWC = expected change in average costs for roundwood expressed in dollars per cord (78 ft³ solid wood per cord)
- $\bar{Q}$ = current annual volume of lumber output to be converted to SDR production in thousands of board feet
- IRR = internal rate of return desired for investment monies, expressed as a percent (should be same as rate-of-return for current operations).

Equations (7) and (8) may be used to estimate a change in investment limits associated with a change in production volume due to a shift to SDR or EGAR manufacture. Production could either be increased, or decreased. A decrease in production volume will cause a reduction in the investment limit that might be calculated on the basis of increased lumber realization and/or reduction in wood costs. For most hardwood mills, either the same production volume or an increase in production volume should be realized.

$$\text{SDR \$L}/\Delta\text{Q} = \Delta\text{Q}[\text{AR}(4.4720 - 0.1161 * \text{IRR} - \text{WC}(9.8363 - 0.2554 * \text{IRR})] \quad (7)$$

$$\text{EGAR \$L}/\Delta\text{Q} = \Delta\text{Q}[\text{AR}(3.9431 - 0.0814 * \text{IRR}) - \text{WC}(9.0213 - 0.1869 * \text{IRR})] \quad (8)$$

where

- ΔQ = expected change in sawmill lumber output per year, expressed in thousands of board feet
- AR = average realization for lumber output in dollars per thousand board feet
- WC = average cost for roundwood expressed as dollars per cord, assuming 78 ft³ of solid wood per cord.

Sample Applications of the Equations

The equations presented in this paper were used to calculate the investment limits for new SDR and EGAR mills and for converting existing mills to the SDR and EGAR processes.

Assumptions

Calculations of the investment limits for the SDR and EGAR processes were based on the following assumptions:

Revenues.—The estimates of revenues which would be produced by the type of mills included in this study were based on the free on board (f.o.b.) mill prices for southern pine framing lumber, produced in sawmills in the southeastern United States, during a recent 5-year period (Random Lengths 1979 through 1983). The high prices used in this study were from the October 5, 1979, price report; low prices were from the April 25, 1980, price report; and average prices are the average of these high and low prices (table 1). The average model prices used for analysis was $237 per thousand board feet for SDR random length, random width lumber, and $280 per thousand board feet for EGAR random length, 10- and 12-inch-wide lumber.

Prices.—Southern pine framing lumber prices were used because this product would be competitive with low- to medium-density hardwood lumber. The shipping distances from primary market centers are also comparable and shipping weights about equal. Low- to medium-density hardwoods (specific gravity of 0.45 or less) cannot be expected to compete with southern pine for engineered uses on a one-to-one basis because of lower strength properties. Such species as yellow-poplar and sweetgum, however, can be used in truss fabrication and wall framing where their strength properties will satisfy design specifications. Price differentials that may result from use limitations are not speculated upon here.

Yield.—Using lumber recovery predicted by the Best Opening Face (BOF) program (Lewis and Hallock 1973) and a sample of log sizes ranging in diameter from 5 to 12 inches, we computed f.o.b. mill value of the SDR product mix to be about $237 per thousand board feet—based on average prices (tables 2 and 3). This figure is based on the following recovery estimates:

Dimensions (85 pct, 10 ft and longer)	Grades
2 by 4, 25 pct	2 by 4
2 by 6, 19 pct	truss-framing, 30 pct
2 by 9, 40 pct	standard and better, 60 pct
2 by 10, 13 pct	utility, 10 pct
2 by 12, 3 pct	
	2 by 6
	No. 2 and Better, 90 pct
	No. 2, 10 pct

On the same basis, an EGAR mill would average from $270 to $340 per thousand board feet, depending on whether 2 by 10's or 2 by 12's are produced. On this basis, an EGAR mill might average from $33 to $103 per thousand board feet more than an SDR mill. This assumes that about the same demand and scarcity of supply will continue for wide-dimension lumber (2 by 10's and 2 by 12's). Floor trusses manufactured from 2 by 3's and 2 by 4's have been replacing wide lumber in many applications. This replacement will continue, of course, only as long as inplace costs for fabricated trusses remain competitive with those of wide-width lumber. Potential investors in new sawmills should consider this factor.

Wood Costs.—Wood costs were assumed to be $45/cord (78-ft^3 solid wood/cord). Low wood cost is an important factor to economic attractiveness of SDR and EGAR lumber manufacture. Because approximately one-half of all log volumes are transformed into residues, even with high levels of sawmilling efficiency, a dollar change in wood costs has approximately twice the effect of a dollar change in lumber realization. A reduction in wood costs and/or increase in lumber realization will often provide a substantial basis for new investment.

Other Assumptions.—A productive life of 10 years was assumed for mills using both systems. Other assumptions related to analysis are reflected from the discounted cash flow analyses displayed in the appendix and estimates presented in tables 1 through 5.

The results for SDR are based on assumptions of an after-tax IRR[1] of 20 percent, an average price of $237 per thousand board feet for lumber, and an average wood cost of $45 per cord (1984 basis). Working capital requirements are based on operating costs indicated in tables 2 through 5. The results for EGAR are based on assumption of an after-tax IRR of 25 percent, an average price of $280 per thousand board feet for lumber, and an average wood cost of $45 per cord.

[1]IRR is rate of return on all monies required to finance a project.

Investment Limits for a New SDR Mill

Based on the best estimates available and given assumptions, up to $2,500,000 could be viably spent for construction of an SDR sawmill rated for 12 million board feet of output per year but only $753,000 for an SDR sawmill rated for 6 million board feet per year, using equation (1). Also, see tables A1 and A2.

Investment Limits for a New EGAR Mill

Based on the best estimates available and given assumptions, up to $3 million could be viably spent for construction of an EGAR sawmill rated for 12 million board feet of output per year, but only $1 million for an EGAR sawmill rated for 6 million board feet per year, using equation (2). Also, see tables A3 and A4.

Investment Limits for Modifying a Mill for SDR

In a mill modified for the SDR process, a $10 per cord reduction in wood costs and $10 per thousand board foot increase in lumber realization will provide a basis for an investment limit of $206,349—assuming a 20 percent after tax return on investment for 3 million board feet of SDR lumber manufacture per year. This estimate is calculated using equation (5). This calculation assumes there will be no change in the annual average volume of lumber ouput.

Assuming mill modification will effect an increase of 200 thousand board feet of lumber production per year, via SDR lumber manufacture, such an increase would provide basis for an investment limit of $59,355—assuming a 20 percent return on investment, an average realization for lumber of $237 per thousand board feet, and wood costs of $45 per cord. This is an additional investment limit that may be added to the previous calculation, which would provide a total investment limit of $265,704. This estimate is calculated using equation (7).

Table 2.—Estimates of roundwood input and product outputs per thousand board feet of lumber output for SDR and EGAR sawmills

Item	Type of sawmill	
	SDR	EGAR
	—— *Ovendry ton* ——	
Roundwood input[1]		
Bark and log trim	0.2438	0.2140
Trimmed logs	1.6252	1.4268
Total	1.8690	1.6408
Product outputs		
Dry lumber[2,3]	.8150	.8150
Wood chips[2]	.4645	.2975
Dry sawdust and shavings[2]	.1744	.1638
Hogged fuel[2]	.0480	.0422
Fuel for dry kilns[4]	.3671	.3223
Total	1.8690	1.6408

[1]Assumptions: average ovendry weight of 28.8 lb/ft^3, at green volume.

[2]Marketable output.

[3]Assumptions: 56.6 ft^3/1,000 fbm, or 1,630 ovendry lb/1,000 fbm of lumber.

[4]Assumptions: drying from 85 pct to 10 pct moisture content, dry basis; 2,700 Btu/lb of H_2O removed; heat energy to steam, 6,150 Btu/ovendry lb of wood/bark fuel.

Table 3.—High, low, and average free on board mill values for southern pine lumber from the southeastern United States since January 1979[1]

Dimension size	Average	High	Low
In.	—— *Dol/1,000 fbm* ——		
2 by 4's	227	290	165
2 by 6's	236	298	174
2 by 8's	225	265	185
2 by 10's	270	327	214
2 by 12's	342	402	282
SDR mill average[2]	237	290	185

[1]Assumptions: 2 by 4's run 30 pct truss-framing grade, 60 pct Standard and Better, and 10 pct Utility; and 2 by 6 and wider run 90 pct No. 2 and Better and 10 pct No. 3. High prices are from Random Lengths October 5, 1979, price report. Low prices are from Random Lengths April 25, 1980, price report. Average values are the average of high and low prices.

[2]Assumptions: average product mix of 25 pct 2 by 4, 19 pct 2 by 6, 40 pct 2 by 8, 13 pct 2 by 10, and 3 pct 2 by 12.

4.—Summary of estimated manufacturing costs for SDR :GAR sawmills (1984 basis)

	SDR mill		EGAR mill	
	Dol/ 1,000 fbm	*Dol/yr*	*Dol/ 1,000 fbm*	*Dol/yr*
ating costs				
od cost				
5 per cord)[1]	$ 53.47	0	$ 51.43	0
sin				
¢/lb. solids)	0	0	4.67	0
ctricity				
5¢/kWh)[2]	1.74	0	1.64	0
ipping	2.00	0	2.00	0
bor	62.50	$186,000	62.50	$228,000
neral overhead	*0*	*120,000*	—	*120,000*
llorem costs				
cal taxes				
d insurance	1.15	48,500	1.45	58,200
intenance				
d supplies	15.00	0	18.00	0
l	$135.86	$354,500	$141.69	$406,200
reciation				
ol/million				
l of facilities				
sts)[3]				
irst 5 years	$90,100		$90,583	
econd 5 years	96,220		96,703	

od costs assumed to be $45 per cord (78 ft³/cord), or $40 per dry ton (ODT); wood chips worth $40 per ODT; sawdust and vings $12 per ODT; hogged fuel $8 per ODT.

AR system uses less electricity for ripping because of wide- th lumber production.

preciation is based on straight line allowances using 20 yr as seful life for buildings, 10 yr for processing equipment and dry s, and 5 yr for mobile equipment. Replacement costs for ile equipment is assumed to increase 6 pct per year and to e a retirement value of 10 pct of original purchase costs.

le 5.—Labor requirements for a two-shift (4,000 hr/yr) ration for SDR and EGAR sawmills

	SDR		EGAR	
	Variable	**Fixed**	**Variable**	**Fixed**
	Hr/million fbm[1]	*Hr/yr*	*Hr/million fbm*	*Hr/yr*
l	730	2,200	730	2,200
mill and steam	2,365	7,000	2,365	7,000
t and planer	1,095	3,200	1,095	3,200
s	1,455	4,385	1,155	4,385
R	0	0	300	4,038
ping	365	1,100	365	1,100
l	6,010	17,885	6,010	21,923

urs per million fbm is hours per million board feet of ber output. For analysis, labor rates were assumed to be er hour, plus 30 pct for fringe benefits, or a total of $10.40 hour.

Literature Cited

Boone, R. S.; Maeglin, R. R. High-temperature drying of 7/4 yellow-poplar flitches for S-D-R studs. Res. Pap. FPL 365. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1980.

Bulgrin, E. H.; Harpole, G. B.; Williston, E. Edge, Glue, and Rip: The EGAR program. In: Proceedings, 8th sawmill clinic, Modern sawmill techniques. Portland, OR: Miller Freeman Publishers; 1978.

Gerhards, C. C. Effect of high temperature drying on bending strength of yellow-poplar 2 by 4's. Forest Products Journal. 33(2): 61-67; 1983.

Harpole, G. B. Economics of manufacturing structural lumber from low- to medium-density hardwoods. Res. Pap. FPL 432. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1983.

Harpole, G. B.; Maeglin, R. R.; Boone, R. S. Economics of manufacturing straight structural lumber from hardwoods. In: Proceedings, Mid-south FPRS section symposium on utilization of low-grade southern hardwoods; 1980. Nashville, TN: Forest Products Research Society; 1981.

Harpole, G. B.; Williston, E.; Hallock, H. Investment opportunity: The FPL EGAR lumber manufacturing system. Res. Pap. FPL 310. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1979.

Kling, R. Edge gluing as applied to EGAR lumber. In: Proceedings, 8th sawmill clinic; Modern sawmill techniques. Portland, OR: Miller Freeman Publishers; 1979.

Lewis, D. W.; Hallock, Hiram Y. Using computers to increase lumber yield—Best Opening Face program. In: Proceedings, 4th wood machining seminar. Richmond, CA: University of California, Forest Products Laboratory; 1973: 233-242.

Maeglin, R. R. Yellow-poplar studs by S-D-R. Southern Lumberman. 1978 December 15: 58-60.

Maeglin, R. R.; Boone, R. S. The manufacture of quality yellow-poplar studs using the Saw-Dry-Rip concept. Forest Products Journal. 33(3): 10-18; 1983.

Random Lengths. Published by Random Lengths Publications, Inc., Eugene, OR; 1979, 1980, 1981.

Stumbo, Donald A. Yellow-poplar framing lumber for building construction. In: Proceedings, Mid-south FPRS section symposium on utilization of low-grade southern hardwoods; 1980. Nashville, TN: Forest Products Research Society; 1981.

U.S. Department of Agriculture, Forest Service. An analysis of the timber situation in the United States 1952-2030 (review draft). Table 24. Washington, DC: U.S. Department of Agriculture; 1980. 68 p.

ppendix
kample cash flow analyses

ıe four tables in this appendix are cash flow analyses
r new SDR and EGAR mills producing 6 million and
: million board feet per year.

Analysis parameters

Initial investment, year 0		Effective tax rate	0.4600	Original cash equity	$0.	Variable costs/gross revenue	= 0.7056
Facilities cost	$752,765	Borrowing rate	.0000	Ending value of equity	$1,649,857.	Fixed costs/gross revenue	= .0961
Working capital	$121,591.	Reinvestment rate	.0000	Facilities salvage value	$144,832.	Depreciation/gross revenue	= .0380
Total investment	$874,357.	Internal rate of return	.2000	Present value of investment (i = 0.2000)	$ − 39.	Tax costs/gross revenue	= .0710
						After tax profit/gross revenue	= .0893

Financial summary (year-end values, dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues										
Unit sales	4,800.	6,000.	6,000.	6,000.	6,000.	6,000.	6,000.	6,000.	6,000.	6,000.
Unit price	237.	251.	266.	282.	299.	317.	336.	358.	378.	400.
Gross sales	1,137,600.	1,507,320.	1,597,771.	1,693,602.	1,795,244.	1,902,945.	2,017,138.	2,150,558.	2,266,482.	2,402,438.
Interest income - expense	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Gross revenues	1,137,600.	1,507,320.	1,597,771.	1,693,602.	1,795,244.	1,902,945.	2,017,138.	2,150,558.	2,266,482.	2,402,438.
Costs										
Variable manufacturing cost	652,128.	863,111.	915,420.	969,910.	1,028,758.	1,089,786.	1,157,353.	1,227,099.	1,301,205.	1,377,490.
Selling expense	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Other variable cost	186,000.	197,160.	208,990.	221,529.	234,821.	248,910.	263,845.	279,675.	296,456.	314,243.
Total variable cost	838,128.	1,060,271.	1,124,410.	1,191,439.	1,263,579.	1,338,696.	1,421,197.	1,506,774.	1,597,660.	1,691,733.
Unit variable cost	175.	177.	187.	199.	211.	223.	237.	251.	266.	282.
Profit contribution	299,472.	447,049.	473,361.	502,163.	531,665.	564,249.	595,940.	643,784.	668,822.	710,705.
Fixed manufacturing cost	120,000.	127,200.	134,832.	142,922.	151,497.	160,587.	170,222.	180,436.	191,262.	202,737.
Advalorem cost	14,604.	15,480.	16,409.	17,393.	18,437.	19,543.	20,716.	21,959.	23,276.	24,673.
Total fixed cost	134,604.	142,680.	151,241.	160,315.	169,934.	180,130.	190,938.	202,395.	214,538.	227,410.
Facilities cost	0.	0	0.	0.	93,343.	0.	0.	0.	0.	− 144,832.
Working capital	28,777.	9,088.	9,513.	10,220.	10,664.	11,664.	12,129.	12,879.	13,368.	− 239,893.
Total investment	28,777.	9,088.	9,513.	10,220.	104,007.	11,664.	12,129.	12,879.	13,368.	− 384,725.
Depreciation	67,824.	67,824.	67,824.	67,824.	67,824.	72,431.	72,431.	72,431.	72,431.	72,431.
Taxable earnings	97,044.	236,545.	254,296.	274,024.	293,907.	311,688.	332,572.	368,959.	381,853.	410,865.
After tax earnings	170,739.	195,559.	205,144.	215,797.	226,534.	240,743.	252,020.	271,669.	278,632.	294,298.
After tax net cash flow	141,961.	186,471.	195,631.	205,577.	122,527.	229,079.	239,891.	258,790.	265,264.	679,023.
Accumulated net cash flow	− 732.4M	− 545.9M	− 350.3M	− 144.7M	− 22.2M	206.9M	446.8M	705.6M	970.8M	1,649.9M

Sensitivity analysis

Values	Internal rates of return (IRR); values adjusted to					Year 1 unit cost (in dollars per thousand board feet), IRR = 0.20; values adjusted to				
	0.80	0.90	1.00	1.10	1.20	0.80	0.90	1.00	1.10	1.20
Unit sales	0.109	0.157	0.200	0.240	0.278	260.7	247.6	237.0	228.4	221.2
Unit price	− .053	.088	.200	.299	.390			237.0		
Unit variable cost	.348	.275	.200	.120	.033	201.9	219.4	237.0	254.6	272.1
Total fixed cost	.221	.210	.200	.190	.179	232.2	234.6	237.0	239.4	241.9
Facilities cost	.238	.217	.200	.186	.173	229.5	233.3	237.0	240.6	244.2

Analysis parameters

Initial investment (year 0)		Effective tax rate	0.4600	Original cash equity	$0	Variable costs / gross revenue	= 0.6393
Facilities cost	$2,500,000	Borrowing rate	0000	Ending value of equity	$4,906,837	Fixed costs / gross revenue	= 0601
Working capital	$207,344	Reinvestment rate	0000	Facilities salvage value	$481,000	Depreciation / gross revenue	= 0630
Total investment	$2,707,344	Internal rate of return	2030	Present value of investment (i = 0.2000)	$40,978	Tax costs / gross revenue	= 1047
						After tax profit / gross revenue	= 1328

Financial summary (year-end values, dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues										
Unit sales	9,600	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Unit price	237	251	266	282	299	317	336	358	378	400
Gross sales	2,275,200	3,014,640	3,195,542	3,387,203	3,590,488	3,805,890	4,034,275	4,301,117	4,532,965	4,804,876
Interest income - expense	0	0	0	0	0	0	0	0	0	0
Gross revenues	2,275,200	3,014,640	3,195,542	3,387,203	3,590,488	3,805,890	4,034,275	4,301,117	4,532,965	4,804,876
Costs										
Variable manufacturing cost	1,304,256	1,726,221	1,830,841	1,939,819	2,057,516	2,179,572	2,314,706	2,454,198	2,602,409	2,754,979
Selling expense	0	0	0	0	0	0	0	0	0	0
Other variable cost	186,000	197,160	208,990	221,529	234,821	248,910	263,845	279,675	296,456	314,243
Total variable cost	1,490,256	1,923,381	2,039,830	2,161,348	2,292,337	2,428,482	2,578,550	2,733,873	2,898,865	3,069,222
Unit variable cost	155	160	170	180	191	202	215	228	242	256
Profit contribution	784,944	1,091,259	1,155,712	1,225,855	1,298,151	1,377,408	1,455,725	1,567,243	1,634,100	1,735,654
Fixed manufacturing cost	120,000	127,200	134,832	142,922	151,497	160,587	170,222	180,436	191,262	202,737
Advalorem cost	48,500	51,410	54,495	57,764	61,230	64,904	68,798	72,926	77,302	81,940
Total fixed cost	168,500	178,610	189,327	200,686	212,727	225,491	239,020	253,362	268,564	284,677
Facilities cost	0	0	0	0	310,000	0	0	0	0	−481,000
Working capital	55,404	15,896	16,610	17,879	18,614	20,450	21,208	22,524	23,309	−419,237
Total investment	55,404	15,896	16,610	17,879	328,614	20,450	21,208	22,524	23,309	−900,237
Depreciation	225,250	225,250	225,250	225,250	225,250	240,550	240,550	240,550	240,550	240,500
Taxable earnings	391,194	687,399	741,136	799,919	860,174	911,367	976,155	1,073,331	1,124,986	1,210,427
After tax earnings	604,245	596,445	625,463	657,206	689,744	732,688	767,674	820,149	848,043	894,181
After tax net cash flow	548,840	580,550	608,854	639,328	361,130	712,239	746,466	797,625	824,734	1,794,418
Accumulated net cash flow	−2,158.5M	−1,578.0M	−969.1M	−329.8M	31.4M	743.6M	1,490.1M	2,287.7M	3,112.4M	4,906.8M

Sensitivity analysis

Values	Internal rates of return (IRR); values adjusted to					Year 1 unit cost (in dollars per thousand board feet), IRR = 0.20; values adjusted to				
	0.80	0.90	1.00	1.10	1.20	0.80	0.90	1.00	1.10	1.20
Unit sales	0.144	0.175	0.203	0.231	0.257	259.1	246.1	235.7	227.2	220.1
Unit price	045	130	.203	271	334			235.7		
Unit variable cost	295	250	.203	156	105	203.9	219.8	235.7	251.6	267.5
Total fixed cost	212	208	.203	200	195	232.7	234.2	235.7	237.2	238.7
Facilities cost	248	224	.203	187	173	223.2	229.5	235.7	241.8	247.6

Initial investment, year 0		Effective tax rate	0.4000	Original cash equity	$0	Variable costs, gross revenue	= 0.6000
Facilities cost	$1,021,378	Borrowing rate	.0000	Ending value of equity	$2,752,738	Fixed costs, gross revenue	= .0845
Working capital	$130,991	Reinvestment rate	.0000	Facilities salvage value	$191,576	Depreciation, gross revenue	= .0439
Total investment	$1,152,369	Internal rate of return	.2500	Present value of investment (i = 0.2500)	$ − 31	Tax costs, gross revenue	= .1015
						After tax profit, gross revenue	= .1262

Financial summary (year-end values, dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues										
Unit sales	4,800	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Unit price	280	297	315	333	353	375	397	421	446	473
Gross sales	1,344,000	1,780,800	1,887,648	2,000,880	2,120,969	2,248,214	2,383,111	2,526,098	2,677,671	2,838,329
Interest income										
expense	0	0	0	0	0	0	0	0	0	0
Gross revenues	1,334,000	1,780,800	1,887,648	2,000,880	2,120,969	2,248,214	2,383,111	2,526,098	2,677,671	2,838,329
Costs										
Variable manufacturing cost	680,112	901,292	955,512	1,012,802	1,073,161	1,137,612	1,206,155	1,278,791	1,355,518	1,436,338
Selling expense	0	0	0	0	0	0	0	0	0	0
Other variable cost	228,000	241,680	256,181	271,552	287,845	305,115	323,422	342,827	363,397	385,201
Total variable cost	908,112	1,142,972	1,211,693	1,284,354	1,361,006	1,442,727	1,529,578	1,621,618	1,718,915	1,821,539
Unit variable cost	189	190	202	214	227	240	255	270	286	304
Profit contribution	435,888	637,829	675,943	716,526	759,963	805,486	853,534	904,480	958,756	1,016,791
Fixed manufacturing cost	120,000	127,200	134,832	142,922	151,497	160,587	170,222	180,436	191,262	202,737
Advalorem cost	19,815	21,004	22,264	23,600	25,016	26,517	28,108	29,988	31,582	33,477
Total fixed cost	139,815	148,204	157,096	166,522	176,513	187,104	198,330	209,424	222,844	236,214
Facilities cost	0	0	0	0	126,651	0	0	0	0	− 191,576
Working capital	30,406	9,702	10,261	10,830	11,539	12,260	12,892	13,840	14,499	− 257,219
Total investment	30,406	9,702	10,261	10,830	138,190	12,260	12,892	13,840	14,499	− 448,796
Depreciation	92,520	92,520	92,520	92,520	92,520	98,771	98,771	98,771	98,771	98,771
Taxable earnings	203,553	397,105	426,327	457,485	490,931	519,612	556,634	556,434	637,142	681,806
After tax earnings	275,169	306,957	322,736	339,562	357,623	379,361	399,245	420,765	442,827	466,946
After tax net cash flow	242,763	297,255	312,476	328,731	219,433	367,102	386,353	406,925	428,328	915,742
Accumulated net cash flow	− 909.6M	− 612.4M	− 299.9M	28.9M	248.3M	615.4M	1,001.7M	1,408.7M	1,837.0M	2,752.7M

Sensitivity analysis

Values	Internal rates of return (IRR); values adjusted to					Year 1 unit cost (in dollars per thousand board feet), IRR = 0.25; values adjusted to				
	0.80	0.90	1.00	1.10	1.20	0.80	0.90	1.00	1.10	1.20
Unit sales	0.160	0.207	0.250	0.290	0.329	312.5	294.5	280.0	268.2	258.3
Unit price	.044	.155	.250	.336	.417			280.0		
Unit variable cost	.370	.310	.250	.188	.121	241.7	260.8	280.0	299.2	318.3
Total fixed cost	.266	.258	.250	.242	.234	274.9	277.4	280.0	282.6	285.1
Facilities cost	.298	.272	.250	.232	.216	267.2	273.6	280.0	286.3	292.4

Table A-4.—Discounted cash flow analysis for an EGAR sawmill with a capacity of 12 million board feet per year. Inflation is assumed to be 6 percent and an investment tax credit of $207,750.00 is included

Analysis parameters

Initial investment, year 0		Effective tax rate	0.4600	Original cash equity	$0	Variable costs/gross revenue	= 0.5750
Facilities cost	$3,000.00	Borrowing rate	.0000	Ending value of equity	$7,432,874	Fixed costs/gross revenue	= .0538
Working capital	$220,803	Reinvestment rate	.0000	Facilities salvage value	$562,700	Depreciation/gross revenue	= .0644
Total investment	$3,220,803	Internal rate of return	.2510	Present value of investment (i = 0.2500)	$20,971	Tax costs/gross revenue	= .1364
						After tax profit/gross revenue	= .1704

Financial summary (year-end values, dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenues										
Unit sales	9,600	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Unit price	280	297	315	333	353	375	397	421	446	473
Gross sales	2,688,000	3,561,600	3,775,271	4,001,760	4,241,938	4,496,427	4,766,222	5,052,196	5,355,342	5,676,658
Interest income - expense	0	0	0	0	0	0	0	0	0	0
Gross revenues	2,688,000	3,561,600	3,775,271	4,001,760	4,241,938	4,496,427	4,766,222	5,052,196	5,355,342	5,676,658
Costs										
Variable manufacturing cost	1,360,224	1,802,583	1,911,025	2,025,604	2,146,322	2,275,224	2,412,311	2,557,581	2,711,036	2,872,675
Selling expense	0	0	0	0	0	0	0	0	0	0
Other variable cost	228,000	241,680	256,181	271,552	287,845	305,115	323,422	342,827	363,397	385,201
Total variable cost	1,588,224	2,044,263	2,267,205	2,297,156	2,434,167	2,580,339	2,735,733	2,900,409	3,074,433	3,257,876
Unit variable cost	165	170	181	191	203	215	228	242	256	271
Profit contribution	1,099,776	1,517,337	1,608,066	1,704,604	1,807,771	1,916,087	2,030,490	2,151,787	2,280,909	2,418,782
Fixed manufacturing cost	120,000	127,200	134,832	142,922	151,497	160,587	170,222	180,436	191,262	202,737
Advalorem cost	58,200	61,692	65,394	69,317	73,476	77,885	82,558	85,144	92,762	98,328
Total fixed cost	178,200	188,892	200,226	212,239	224,973	238,472	252,780	265,580	284,024	301,065
Facilities cost	0	0	0	0	372,000	0	0	0	0	−562,700
Working capital	58,341	16,784	17,746	18,718	19,959	21,213	22,184	24,059	25,060	−444,868
Total investment	58,341	16,784	17,746	18,718	391,959	21,213	22,184	24,059	25,060	−1,007,568
Depreciation	271,750	271,750	271,750	271,750	271,750	290,110	290,110	290,110	290,110	290,110
Taxable earnings	649,826	1,056,695	1,136,090	1,220,615	1,311,048	1,387,506	1,487,600	1,596,098	1,706,775	1,827,607
After tax earnings	830,406	842,365	885,239	930,882	979,716	1,039,363	1,093,414	1,152,003	2,211,769	1,277,018
After tax net cash flow	772,065	825,581	867,493	912,164	587,757	1,018,150	1,071,229	1,127,944	1,186,708	2,284,586
Accumulated net cash flow	−2,448.7M	−1,623.2M	−755.7M	−156.5M	744.3M	1,762.4M	2,833.6M	3,961.6M	5,148.3M	7,432.9M

Sensitivity analysis

Values	Internal rates of return (IRR); values adjusted to					Year 1 unit cost (in dollars per thousand board feet), IRR = 0.25, values adjusted to				
	0.80	0.90	1.00	1.10	1.20	0.80	0.90	1.00	1.10	1.20
Unit sales	0.187	0.221	0.251	0.281	0.310	311.5	293.6	279.2	267.5	257.7
Unit price	156	183	251	316	376			279.2		
Unit variable cost	331	291	251	211	169	245.0	262.1	279.2	296.3	313.4
Total fixed cost	259	255	251	249	245	275.9	277.6	279.2	280.8	282.5
Facilities cost	305	276	251	232	215	260.4	269.9	279.2	288.4	297.5

The Forest Products Laboratory (USDA Forest Service) has served as the national center for wood utilization research si. ·9 1910. The Laboratory, on the University of Wisconsin-Madison campus, has achieved worldwide recognition for its contribution to the knowledge and better use of wood.

Early research at the Laboratory helped establish U.S. industries that produce pulp and paper, lumber, structural beams, plywood, particleboard and wood furniture, and other wood products. Studies now in progress provide a basis for more effective management and use of our timber resource by answering critical questions on its basic characteristics and on its conversion for use in a variety of consumer applications.

Unanswered questions remain and new ones will arise because of changes in the timber resource and increased use of wood products. As we approach the 21st Century, scientists at the Forest Products Laboratory will continue to meet the challenge posed by these questions.

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